

Plants Occurring on Calcareous Rock Outcrops in North Carolina

HENRY J. OOSTING

The soil preferences and ranges of acid or basic tolerance of many plants are well known. Those species with extreme requirements are of special interest because their distribution is frequently limited and they often occur sparsely or only locally within their ranges. Calcicoles, or plants which grow in calcareous habitats, may be in the latter category, particularly when limestone is rare or absent.

Limestone outcrops and calcareous soils are infrequent and widely isolated in North Carolina and, where they occur, are limited in extent. It would thus seem of interest to know something of the species associated with these areas and especially to determine whether calcicolous species are uniformly present when the habitats are so small and widely isolated. The state has been included in the reported ranges of several calcicoles but, of those species which are thought to be definitely restricted to calcareous habitats, there are few specimens on record. These same species are far more abundant in Tennessee, often in counties contiguous with the North Carolina line, for limestone is common on the Tennessee side of the Great Smoky Mountains.

With the objective of determining the species associated with the limestone and of adding new taxonomic records for North Carolina, as many calcareous habitats were visited as possible. Considerable difficulty was experienced in locating the usually small and isolated stations. Soil maps, available for only scattered counties, indicated two stations. Otherwise outcrops were located by chance. Inquiries concerning the sites of old lime kilns proved most fruitful although they led to several unsuccessful searches as well. Old quarries are all too frequently well below ground level and are today filled with water with no limestone showing at the surface in the vicinity. All of the calcareous outcrops visited, as well as a few rumored localities not yet seen, are in or near the mountains. Visits to shell-marl deposits in different parts of the Coastal plain proved fruitless. Here the calcareous material is invariably buried under several feet of acid soil. A few shell-marl strata were found

exposed in under-cut river bluffs but these were subject to constant disturbance and supported no plants of interest. Other exposures were submerged in old quarries. No calcicolous flowering plants were found.

The list of vascular plants collected on the outcrops or on associated calcareous soil is an extensive one. However, it seems reasonable to eliminate from consideration those dominant species with a wide range in the state and also most of the species which appeared at only one station. Of the latter, only those have been retained which are thought to have affinities with alkaline habitats. In the tabulation of occurrences of species the stations are indicated by letter as follows:

A—Madison County, steep south-facing bluff along the French Broad River just west of Hot Springs. Vegetation scrubby and cover incomplete, for soil is thin and anchorage largely restricted to crevices in rock.

B—Madison County, low bluff along "Shut-In-Creek," a small tributary of the French Broad flowing from the south, four miles west of Hot Springs. Thin mantle of soil overlying calcareous rock. Mostly rich hardwood forest.

C—McDowell County, site of old lime kiln six miles north of Marion on the east side of road to Linville Falls. Open hardwoods. Soil only a thin mantle and numerous small outcrops of bare rock.

D—McDowell County, eleven miles north of Marion on west side of road to Linville Falls. Lime plant in operation. Pastured slope with numerous outcrops and open woods on calcareous soil.

E—Transylvania County, Toxaway River gorge, somewhat below site of defunct Lake Toxaway. Records from several outcrops, some in shady woods some not.

F—Swain County, Nantahala Gorge, east bluff of river near roadside spring, "Blowing Springs," north of Nantahala Station. Rich hardwoods on thin alkaline soil overlying shady marble.

G—Swain County, Nantahala Gorge, bluff on west side of river near site of active quarrying, just north of Nantahala Station. Much bare marble, some young hardwoods.

H—Stanly and Montgomery Counties—"Falls of the Yadkin River," falls now inundated by power dams built below Badin. Dr. J. K. Small collected *Asplenium resiliens* here prior to construction of the dams. Apparently the station and the limestone are now cov-

ered by impounded water. Proximity of limestone and the species found, reason for inclusion of this locality. Records are from both bluffs of the river.

I—Yadkin County, "Lime Rock," about five miles north of East Bend, north facing bluff along Yadkin River. Steep shaded bluff, calcareous rock outcropping and site of old lime kilns.

The repeated occurrences (Table 1) of several species bear no relation to the calcareous substratum. *Polystichum acrostichoides*, *Asplenium platyneuron* and *Viburnum acerifolium* are common throughout North Carolina and may be found in almost any forest whether pine or hardwood. Another larger group occurs regu-

TABLE 1. A list of the species collected at two or more of the nine stations where calcareous rock was located. Stations are indicated by letter and collections by X

	STATIONS									
	A	B	C	D	E	F	G	H	I	
<i>Asplenium resiliens</i> ²	X	X	X	X	X	..	X	..	X	** ²
<i>Pellaea atropurpurea</i>	X	X	X	X	X	..	X	..	X	*
<i>Adiantum pedatum</i> .....	..	..	..	X	X	X	X	X	X	+
<i>Asplenium platyneuron</i>	X	X	..	X	..	..	..	X	X	..
<i>Asplenium trichomanes</i> .....	..	..	..	..	X	X	X	X	X	+
<i>Camptosorus rhizophyllus</i> .....	..	X	X	..	..	X	X	..	X	*
<i>Sedum ternatum</i> .....	..	X	..	X	..	X	X	..	X	..
<i>Arisaema triphyllum</i> .....	..	X	X	X	..	..	..	..	X	..
<i>Cystopteris fragilis</i> .....	..	..	..	..	X	X	X	..	X	..
<i>Polypodium polypodioides</i> ...	X	X	X	..	..	..	..	X	..	..
<i>Polystichum acrostichoides</i> ...	X	..	X	..	..	..	X	X	X	..
<i>Aruncus vulgaris</i> .....	..	..	X	..	..	..	X	..	X	..
<i>Asarum canadense</i> .....	..	..	..	..	..	X	X	..	X	..
<i>Botrychium virginianum</i> .....	..	..	..	X	..	..	X	..	X	+
<i>Cheilanthes tomentosa</i>	X	..	..	..	X	..	..	X	..	+
<i>Cystopteris bulbifera</i> .....	..	X	..	..	..	X	X	..	..	**—*
<i>Dryopteris noveboracensis</i> ...	..	..	X	..	X	..	..	..	X	..
<i>Galium circaeans</i> .....	..	X	..	X	..	..	X	..	..	..
<i>Heuchera</i> spp. ....	..	X	..	..	..	..	X	..	X	..
<i>Hydrangea arborescens</i>	X	..	..	..	..	..	X	..	X	..
<i>Iris verna</i> .....	..	X	X	..	..	..	..	..	X	..
<i>Phacelia brevistyla</i> .....	..	X	..	..	..	X	X	..	..	..
<i>Smilacina racemosa</i> .....	..	..	..	X	..	..	X	..	X	..

TABLE 1.—Continued

	STATIONS									
	A	B	C	D	E	F	G	H	I	
<i>Aquilegia canadensis</i>	×	×	+
<i>Carex platyphylla</i>	×	×	..
<i>Caulophyllum thalictroides</i>	×	..	×	..
<i>Cheilanthes alabamensis</i>	×	×	**
<i>Cimicifuga racemosa</i>	×	×
<i>Dioscorea glauca</i>	×	×
<i>Hypericum punctatum</i>	×	×
<i>Magnolia Fraseri</i>	×	×
<i>Mitella diphylla</i>	×	×	+
<i>Philadelphus hirsutus</i>	×	×
<i>Ruellia parviflora</i>	×	×
<i>Scleria oligantha</i>	×	×
<i>Selaginella apoda</i>	×	×	*—+
<i>Viburnum acerifolium</i>	×	×	..
<i>Asplenium cryptolepis</i>	×	**
<i>Carex heterosperma</i>	×	+
<i>Carex plantaginea</i>	×	**
<i>Cheilanthes lanosa</i>	×	..	*—+
<i>Polygala Senega</i>	×	*

¹ Nomenclature is essentially that of Gray's Manual, 7th edition. The exceptions may be found in Small's Manual of the Southeastern Flora or Blomquist's Ferns of North Carolina, 1934. Specimens of all collections are deposited in the Duke University Herbarium.

² Meaning of symbols in terms of manuals and other similar sources of information.

**— found only in calcareous habitats (obligate calciphiles).

*— found characteristically in alkaline habitats but not restricted to them (calciphiles).

+— growing in soils of widely different pH but apparently best suited to calcareous substrata.

larly in any moist, rich hardwood forest especially in or near the mountains. This group includes practically all other species not marked with a symbol. *Arisaema*, *Aruncus*, *Hydrangea* and *Smilacina* are familiar illustrations. It should be noted that these species were found only on the forested portions of areas studied and that here the accumulated organic layer overlying the mineral soil is essentially acid. The significant species were found almost exclusively on exposed limestone or thin mineral soil with an alkaline reaction.

There remain seventeen species which are, according to the manuals, calcicolous in habit. These are the species of particular interest. The nine species marked (+), indicating best development on alkaline substrata, show no significant correlation with these special stations. *Cheilanthes lanosa* was found only once and then was not on calcareous rock. It occurs in several stations in western North Carolina, apparently quite remote from limestone. This is also probably true of *Carex heterosperma*. Of the species found at two stations, *Selaginella apoda* can be of no significance for it appears in moist, shaded situations throughout the state. *Aquilegia canadensis* likewise appears sporadically with no apparent calcareous connections. *Mitella diphylla* is less common and less widespread but would not be classed as primarily calcicolous in North Carolina. Although found at three calcareous localities *Botrychium virginianum* occurs in almost any damp hardwood forest and *Cheilanthes tomentosa*, though by no means common, may be expected on any kind of rocky bluff. The consistent occurrences of *Asplenium trichomanes* and *Adiantum pedatum* suggest a calcareous relationship for, although they may be found on shaded rocky bluffs in all parts of western North Carolina they would hardly be expected with such frequency.

The list includes four calciphiles (*). *Polygala Senega* was found at only one station but, since it is relatively rare in the state, this collection may be significant. The repeated appearances of *Camptosorus* and *Pellaea* indicate their adaptation to alkalinity for they are found only rarely elsewhere. *Cystopteris bulbifera* is definitely an obligate calciphile in North Carolina for it is only found on limestone. Nearer the center of its range, it may not always be so. This situation agrees with observations made by Pesola³ in Finland where, he concluded, calcicolous species become more closely bound by specific habitat factors the nearer they approach the limits of their range, or if they are subjected to extremes in growing conditions.

Four species were found which are usually recognized as growing only in calcareous soils (obligate calciphiles**). Among these,

³ Pesola, V. A. 1928. Kalsiumkarbonaatti kasvimaantieteellisenä teki jänä Suomessa. Ann. Soc. Zoolog.-Bot. Fennicae Vanamo 9 (1): 1-246. n.v. (See Wherry, Ecology 11: 450-452, 1930).

Asplenium resiliens is most noteworthy because of its appearance at seven stations. With two exceptions these all seem to be new records for the state.⁴ *Cheilanthes alabamensis*, too, was found only on limestone but apparently it is not as adaptable as *Asplenium resiliens* for it occurred at only two stations. Finally *Asplenium cryptolepis* and *Carex plantaginea* were found each at one station growing directly upon limestone.

DISCUSSION AND SUMMARY

In a survey of the infrequent limestone outcrops of North Carolina, nine were located and studied botanically. All are in the mountains in the western part of the state and are within the general range of numerous species which are restricted to alkaline habitats. The collections (Table 1) made at these stations are of interest not only because they include several new records for the state but because of the isolated and restricted nature of the outcrops. In spite of the widely separated localities and the distance to the nearest abundant limestone, four obligate calciphiles were found. Of these, *Asplenium resiliens* appeared consistently while *Cheilanthes alabamensis* was found at only two stations and *Asplenium cryptolepis* and *Carex plantaginea* at one. In addition, the calciphile, *Cystopteris bulbifera*, was found at three stations, indicating its obligate nature under the extreme conditions. Several other species with less positive alkaline predilections were rather consistently present.

The survey indicates that certain calciphiles tend to be present wherever there is limestone, within or at the margins of their ranges, even though the stations may be widely separated as in North Carolina. Certain species not necessarily restricted to alkaline habitats tend to become so when near the extremities of their normal distribution. Of these species, apparently favored by a calcareous substratum where it is quite generally available, some seem, here in North Carolina, to be concentrated in alkaline habitats while others are apparently not affected in their numbers or distribution.

DUKE UNIVERSITY,
DURHAM, N. C.

⁴ Blomquist, H. L., and Correll, D. S. 1940. A county check list of North Carolina ferns and fern allies. Jour. Elisha Mitchell Sci. Soc. 56: 53-105.